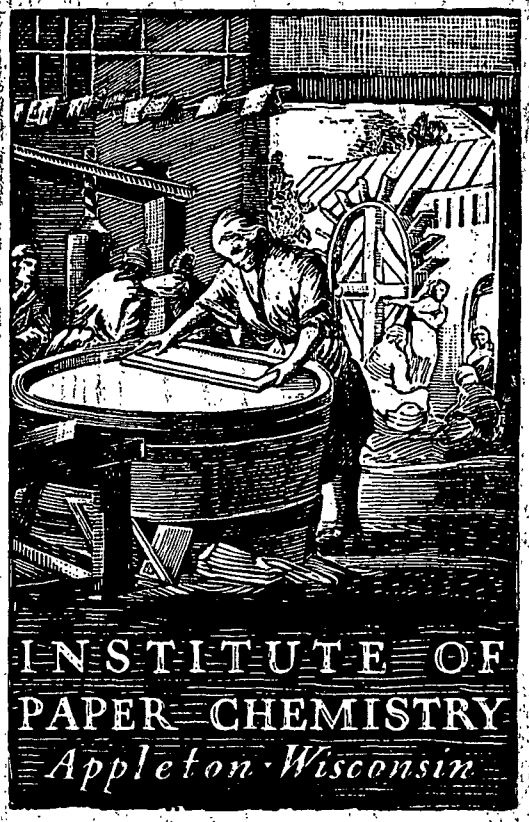

AN INVESTIGATION OF LINTING AND FLUFFING OF OFFSET NEWSPRINT

Project 2949

Report Three

A Progress Report

to

MEMBERS OF GROUP PROJECT 2949

April 19, 1972

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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Bowaters Southern Paper Corporation

International Paper Company

Southwest Forest Industries, Inc.

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THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

AN INVESTIGATION OF LINTING AND FLUFFING OF OFFSET NEWSPRINT

SUMMARY

The lint collected at the end of the press runs has been found by microscopic examination to consist mainly of groundwood of the following characteristics:

1. Ray cells and small aggregates of ray cells.
2. Fragments of tracheid fibers having lengths of about 25 to 100 μm.
3. Segments of fiber tracheids ranging from 0.35 to 0.8 mm. in average length. These are referred to in this report as "partial fibers."
4. Short dense shives with a maximum length of the order of 0.8 mm. Often referred to as "partial shives" in this report.

These components of lint are also found in small amounts in the whole stock of the parent newsprint. The fibrils and fibrillated fibers which are found in the newsprints are not present in appreciable quantity in the lint samples. Fiber segments and shives longer than 1 mm. also are generally not a part of the blanket or ink train lint. These observations are in general accord with those of Browning and Parker (1) who were able to estimate the linting tendency of pulps by microscopic examination.

There is some classification of lint between the blanket and the ink train. The ink train lint tends to be coarser. It may also be less rigid and dense. No comparison has been made between the blanket and ink train lint and the paper debris that deposits on the plate but from the nature of the print defects arising from the debris on the plate, it is apparent that it must contain coarse shives.

The subjectively judged coarseness of the lint appears to correlate well with the degree that the printing quality is degraded by the accumulating lint. As previously reported, the amount of lint does not correlate well with quality degradation.

INTRODUCTION

Report One of this project described the development of press test methods and the lint isolation procedures which have been used in this investigation. Report Two compared five southern and two northern newsprints with respect to linting tendency and evaluated the extent to which print quality was impaired by the accumulating lint. It was concluded that there was little correlation between the amount of lint supplied by a paper and the degree to which the print quality was degraded as a result of lint accumulation. It was, therefore, hypothesized that the nature of the lint must be of greater importance than the amount of lint.

Report Three describes a study of the lint. It compares the lint with the components in the whole newsprints from which it was collected and considers, as well, the relationship between lint characteristics and print degradation.

This is the final report on the present study of linting of offset newsprint. Therefore, it includes a consideration of future work.

EXPERIMENTAL PROCEDURES

Single runs of the wire side and felt side of each of the seven papers examined gravimetrically were chosen for fiber analyses of the lint. Lint recoveries from both the blanket and the ink train were examined individually for each run selected for examination. Fiber analyses of the base stocks are recorded in Report Two, but unstained slides from these stocks were retained for periodic direct comparison with lint slides as desired.

Whenever practical total lint from a given blanket or ink train was utilized to avoid selective sampling. Samples as recovered from gravimetric analysis were placed in a test tube with an appropriate amount of water, shaken, and dispersed, after which a suitable aliquot was diluted to proper consistency for slide preparation. Further analysis procedures follow that of TAPPI standard 401 m-60. However, fiber density of the slides was intentionally reduced to minimize the possibility that fibers would overlay each other and make observation of characteristics more difficult.

Photographs of both blanket and ink train lint, as well as the base sheet stock, were taken utilizing the Zeiss Photomicroscope equipped for transmitted bright field illumination. The 2.5X objective was utilized to take advantage of the greater depth of field and field of view. Three slightly overlapping views were taken to provide the composite photos included as Fig. 5-11 in the Appendix of this report. This procedure was undertaken to minimize selective sampling of pictured areas and provide a representative cross section of the actual components in the individual lints. These photographs are reproduced at 27.5X from the actual negative size of 10X.

In addition, several prints at 68.8X showing specific examples of material involved in linting are included in the body of the report. These were taken with the 6.3X objectives to provide better detail upon enlargement. Panatomic FX35 mm. film was utilized and all slides were stained with "C" stain in the usual manner before photographing.

DISCUSSION OF RESULTS

Table I records the fiber analysis of the lint from these runs. The reader is referred to Report Two for fiber analyses of the base sheets. The paper codes correspond to those used in Report Two. Some of the terms are defined in the footnotes at the end of the table.

TABLE I

FIBER ANALYSIS OF LINT

Paper AO

Run 30 (Felt Side)

Blanket Lint

96%	softwood groundwood. Principal species southern and/or jack pine identification group. Traces of Douglas-fir and spruce and/or hemlock identification group
4%	softwood lightly bleached kraft. Principal species southern and/or jack pine identification group. Trace, Douglas-fir
Trace	nonwood fiber, possibly synthetic

Remarks: Few ray cells. Few fiber fragments. Many partial fibers. Numerous partial shives.

Ink Train Lint

90%	softwood groundwood. Principal species southern and/or jack pine identification group. Trace, Douglas-fir
10%	softwood lightly bleached kraft. Principal species southern and/or jack pine identification group. Traces of Douglas-fir and white pine identification group
Trace	Nonwood fiber, possibly synthetic

TABLE I (Continued)

FIBER ANALYSIS OF LINT

Remarks: Few ray cells. Few fiber fragments. Many partial fibers. Numerous partial shives. Lint is essentially similar to felt side blanket lint, possibly slightly coarser.

Run 42 (Wire Side)

Blanket Lint

92% softwood groundwood. Principal species southern and/or jack pine identification group. Traces of Douglas-fir and spruce and/or hemlock identification group
8% softwood lightly bleached kraft. Principal species southern and/or jack pine. Trace Douglas-fir
Trace wool fibers

Remarks: Few ray cells. Few fiber fragments. Many partial fibers. Numerous partial shives. Wool fibers, presumably paper mill felt fibers fairly numerous may represent 10% of lint. Cannot determine since weight factor not available for actual wool threads vs. wood fibers of the type and size observed.

Ink Train Lint

84% softwood groundwood. Principal species southern and/or jack pine identification group. Trace spruce and/or hemlock identification group
16% softwood lightly bleached kraft. Principal species southern and/or jack pine identification group. Trace spruce and/or hemlock identification group and Douglas-fir
Trace hardwood groundwood species not identified

Remarks: Few ray cells. Few fiber fragments. Many partial fibers. Numerous partial shives. Partial shives begin to exhibit some "brushing" or fibrillation of ends. Softwood fibers tend to be longer than on blanket. Lint seems slightly coarser than blanket lint.

Paper BR

Run 28 (Felt Side)

Blanket Lint

100% softwood groundwood. Species southern and/or jack pine identification group
Trace softwood lightly bleached kraft species not identified

Remarks: Few ray cells. Numerous fiber fragments, viz., less than 50 µm. Some to considerable partial fibers. Few partial shives. Fibers appear shorter than those of AO and DO.

TABLE I (Continued)

FIBER ANALYSIS OF LINT

Ink Train Lint

100% softwood groundwood. Species southern and/or jack pine identification group
Trace softwood lightly bleached kraft southern and/or jack pine identification group.
Possible trace synthetic

Remarks: Some fiber fragments. Mostly partial fibers which appear longer than partial fibers on the blanket. A few partial shives. A few fibrils and a very few fibers showing linted brushing or fibrillation of the ends. Material appears slightly coarser than blanket lint.

Run 43 (Wire Side)

Blanket Lint

100% softwood groundwood. Species southern and/or jack pine identification group
Trace softwood lightly bleached kraft. Species southern and/or jack pine identification group. Trace of Douglas-fir
Trace wool fiber

Remarks: Numerous ray cells. Numerous fiber fragments. A considerable number of partial fibers. Some partial shives. Partial fibers may tend to be summerwood fibers by reason of density, lack of pitting and rigid sticklike structure.

Ink Train Lint

84% softwood groundwood. Southern and/or jack pine identification group
16% softwood lightly bleached kraft. Southern and/or jack pine identification group. Trace of Douglas-fir
Trace hardwood groundwood. Species not identified
Trace hardwood kraft. Species not identified

Remarks: Limited number of small fiber fragments. Predominantly partial fibers; springwood fibers seem to predominate. Some partial shives. Some fibrils and some partial fibers exhibiting limited brushing or fibrillation. Material seems coarser than blanket lint.

TABLE I (Continued)

FIBER ANALYSIS OF LINT

Paper CO

Run 38

Blanket Lint

100% groundwood, principally softwood groundwood. Species southern and/or jack pine identification group. Some hardwood groundwood. Species oak and/or chestnut and maple and/or basswood identified, possibly others. Condition of groundwood prevents quantitative separation of softwood and hardwood
Trace wool fibers
Trace softwood lightly bleached kraft. Species not identified

Remarks: More fines than AO, BR, or DO. Fines divided between fiber tracheid fragments and ray cells but fiber fragments may predominate. Partial fibers both softwood and hardwood. Softwood fibers suggest summerwood fibers predominate by reason of density, lack of pitting and rigid sticklike structure. Few partial shives. Very few hardwood vessel elements present.

Ink Train Lint

95% softwood and hardwood groundwood. Principally softwood species southern and/or jack pine identification group. Some hardwood maple and/or basswood only species identified, possibly others. Unable to quantitatively separate softwood and hardwood due to fiber condition
5% softwood lightly bleached kraft. Principal species southern and/or jack pine identification group. Trace Douglas-fir
Trace hardwood kraft. Oak and/or chestnut only species identified, possibly others

Remarks: Some fiber fragments and ray cells. Predominantly partial fibers; springwood fibers seem to predominate. Limited partial shives. Limited fibrils. Very few vessel elements. Material appears coarser than blanket lint.

Run 31 (Wire Side)

Blanket Lint

100% softwood and hardwood groundwood. Estimate approximately 50% of each but cannot determine with certainty due to fiber condition. Softwood species southern and/or jack pine identification group; oak and/or chestnut only hardwood species identified, possibly others
Trace softwood lightly bleached kraft. Species southern and/or jack pine identification group

TABLE I (Continued)

FIBER ANALYSIS OF LINT

Remarks: More fine material in the form of ray cells and fiber fragments than previous samples. Hardwood and softwood ray cells are numerous but fiber fragments also found. Numerous partial fibers again. Features suggest summerwood fibers predominate. Some partial shives.

Ink Train Lint

100% groundwood. Principally softwood groundwood. Species southern and/or jack pine identification group; some hardwood groundwood; species not identified
Trace wool fiber
Trace softwood lightly bleached kraft. Species southern and/or jack pine identification group

Remarks: Many small fiber fragments and about an equal number of ray cells of similar size. Many partial fibers. Summerwood fibers are suggested due to limited pitting, density, and rigid sticklike structure. A few partial shives. Essentially no hardwood vessel elements. Material slightly coarser than blanket.

Paper DO

Run 29 (Felt Side)

Blanket Lint

100% softwood groundwood. Species southern and/or jack pine identification group
Trace softwood lightly bleached kraft. Species not identified

Remarks: Few ray cells. A limited number of fiber fragments. Numerous partial fibers. Summerwood is suggested by reason of lack of pitting, apparent density, and rigidity. Some partial shives usually with ray section attached.

Ink Train Lint

100% softwood groundwood. Species southern and/or jack pine identification group
Trace softwood lightly bleached kraft. Species not identified
Trace wool fiber

Remarks: A few ray cells. Some fiber segments. Numerous partial fibers. Again summerwood is suspected for reasons given previously. A limited number of partial shives. A few fibrils and a limited number of partial fibers exhibiting limited brushing or fibrillation. Material in ink train slightly coarser than blanket.

TABLE I (Continued)

FIBER ANALYSIS OF LINT

Run 37 (Wire Side)

Blanket Lint

98% softwood groundwood. Southern and/or jack pine identification group
2% softwood lightly bleached kraft. Southern and/or jack pine identification group
Trace wool fiber

Remarks: Limited fiber fragments. Many partial fibers. Springwood fibers appear more numerous than on felt side. Some partial shives. A few fibrils shown.

Ink Train Lint

100% softwood groundwood. Species southern and/or jack pine identification group
Trace softwood lightly bleached kraft. Southern and/or jack pine identification group

Remarks: Limited fiber fragments. Some to numerous partial fibers with fibrillated ends on occasion. A few to limited partial shives often with associated ray crossing. Some fibrils.

Paper FR

Run 32 (Felt Side)

Blanket Lint

100% groundwood. Principally softwood groundwood. Species southern and/or jack pine identification group. Some hardwood groundwood. Maple and/or basswood only species identified, possibly others
Trace wool fiber
Trace softwood lightly bleached kraft. Species southern and/or jack pine identification group

Remarks: Some ray cells. Some small fiber fragments. Principally partial fibers. Summerwood is again suggested. Very limited shive content. Very few vessel elements.

Ink Train Lint

94% groundwood. Principally softwood groundwood. Species southern and/or jack pine identification group. Some hardwood groundwood. Oak and/or chestnut species identified, possibly others
6% softwood lightly bleached kraft. Species southern and/or jack pine identification group

TABLE I (Continued)

FIBER ANALYSIS OF LINT

Remarks: Some ray cells. Some fiber fragments. Many partial fibers. Again summerwood is suggested. Some partial shives. Very few vessel elements. Material may be slightly coarser than the blanket lint.

Run 33 (Wire Side)

Blanket Lint

100% groundwood. Principally softwood groundwood. Species southern and/or jack pine identification group
Trace wool fiber
Trace softwood lightly bleached kraft. Species southern and/or jack pine identification group

Remarks: Limited ray cell content. Some fiber fragments. Many partial fibers. Again summerwood fibers are suggested. Limited partial shives.

Ink Train Lint

92% groundwood. Principally softwood groundwood. Species southern and/or jack pine identification group. Some hardwood groundwood. Oak and/or chestnut species identified, possibly others
8% softwood lightly bleached kraft. Species southern and/or jack pine identification group
Trace wool fiber

Remarks: Limited ray cells. Some fiber fragments. Numerous partial fibers. Again principally summerwood is preferred. Limited partial shives. Limited fibrils and fiber brushing. Material may be slightly coarser than blanket lint.

Paper HC

Run 59 (Felt Side)

Blanket Lint

100% softwood groundwood. Species spruce and/or hemlock identification group
Trace softwood unbleached sulfite. Species spruce and/or hemlock identification group

Remarks: Many ray cells. Some fiber fragments. Many partial fibers. Again summerwood is suggested but differentiation is more difficult than with southern pines. Some to numerous partial shives, usually with ray cells attached. Lint is generally the coarsest of all products studied and seems to contain the most shives.

TABLE I (Continued)

FIBER ANALYSIS OF LINT

Ink Train Lint

100% softwood groundwood. Species spruce and/or hemlock identification group
Trace softwood unbleached sulfite. Species spruce and/or hemlock identification group

Remarks: Some ray cells. Some fiber fragments. Numerous partial fibers. Springwood to summerwood ratio seems similar to base paper. Some partial shives, usually with ray cells attached. Some to numerous fibrils and fibrillated fiber ends.

Run 66 (Wire Side)

Blanket Lint

100% softwood groundwood. Species spruce and/or hemlock identification group
Trace softwood unbleached sulfite. Species spruce and/or hemlock identification group

Remarks: Numerous ray cells; limited fiber fragments. Many partial fibers. Some partial shives, usually with ray cells attached.

Ink Train

100% softwood groundwood. Species spruce and/or hemlock identification group
Trace softwood unbleached sulfite. Spruce and/or hemlock identification group

Remarks: Limited ray cells. Limited fiber fragments. Numerous partial fibers, summerwood preference possible. Some partial shives, usually with ray cells attached. Limited to some fibrils and fibrillated partial fibers.

Paper IT

Run 60 (Top Side)

Blanket Lint

100% softwood groundwood. Species spruce and/or hemlock identification group
Trace softwood unbleached sulfite. Spruce and/or hemlock identification group

Remarks: An extreme number of softwood ray cells. Some fiber fragments and partial fibers.

TABLE I (Continued)

FIBER ANALYSIS OF LINT

Ink Train Lint

90% softwood groundwood. Spruce and/or hemlock identification group
10% softwood unbleached sulfite. Spruce and/or hemlock identification group

Remarks: Some ray cells. Some fiber fragments. Principal material is partial fibers. Some shives, generally with ray crossings attached. Some fibrils and partial fibers with limited fibrillation. An extreme change of fibrous material geometry occurs between the blanket and ink train; and, of course, the ink train material is the coarsest.

Run 66 (Bottom Side)

Blanket Lint

100% softwood groundwood. Spruce and/or hemlock identification group
Trace softwood unbleached sulfite. Spruce and/or hemlock identification group

Remarks: An extreme number of ray cells. A limited number of fiber fragments. Many partial fibers. Some partial shives, usually with ray cells attached.

Ink Train Lint

90% softwood groundwood. Species spruce and/or hemlock identification group
10% softwood unbleached sulfite. Spruce and/or hemlock identification group

Remarks: Some ray cells. Some fiber fragments. Principally partial fibers. Limited partial shives often with ray cells attached. Some fibrils and partial fibers with limited fibrillation. Again an extreme change takes place between fibrous material found on the blanket and the ink train.

Footnotes (simplified explanation of terms; see succeeding discussion for more detail):

1. Ray cells: cells of the rays. These particles do not exceed 70 μm. in their longer dimension and have a specific rectangular geometry.

2. Fiber fragments: fragments of longitudinal tracheids not exceeding 100 μm. and tending to be rectangular in shape.

Footnotes (continued):

3. Partial fibers: fiber fragments expected to be in the range of 0.3 to 0.8 mm. long or about 1/5-1/10, usually around 1/5 length of a normal longitudinal tracheid. Coarseness will vary with individual products.

4. Partial shives: bundles of two or more fibers. Maximum length again is that of partial fibers. Attached rays often associated with shives.

5. Fibrils: threadlike elements of the wall of a fiber; may be free of mother fiber. Fibrils are naturally reduced or absent from most lint products.

Subjective comparison of photographs of the whole stock and of the lint provide a clearer idea of the differences than the above fiber analysis. Photographs of the fibers from the newsprint and of the lint collected in these selected runs are shown as Fig. 5 through 11 in the Appendix. The five photographs for each paper are arranged on facing pages to facilitate comparison of the four lint samples with the fibers of the newsprint from which they came. The individual photographs are composites of three abutting fields and this whole area is shown to assure that the pictures contain representative populations of fibers. The pictures of the ink train lint have been cropped to approximately half size to permit display of all five pictures on facing pages.

Comparison of the pictures shows that the press is highly selective in the type of material it accumulates. The components of the lint are illustrated in Fig. 1 and 2 which are shown at greater magnification to reveal specific characteristics. The lint was found to consist of:

1. Ray cells and aggregates of ray cells (Fig. 1a). These are more prevalent with the northern newsprints.

2. Fiber fragments, that is, tracheid fragments 25-100 μm. in length (Fig. 2b). These are more prevalent with the southern newsprint.

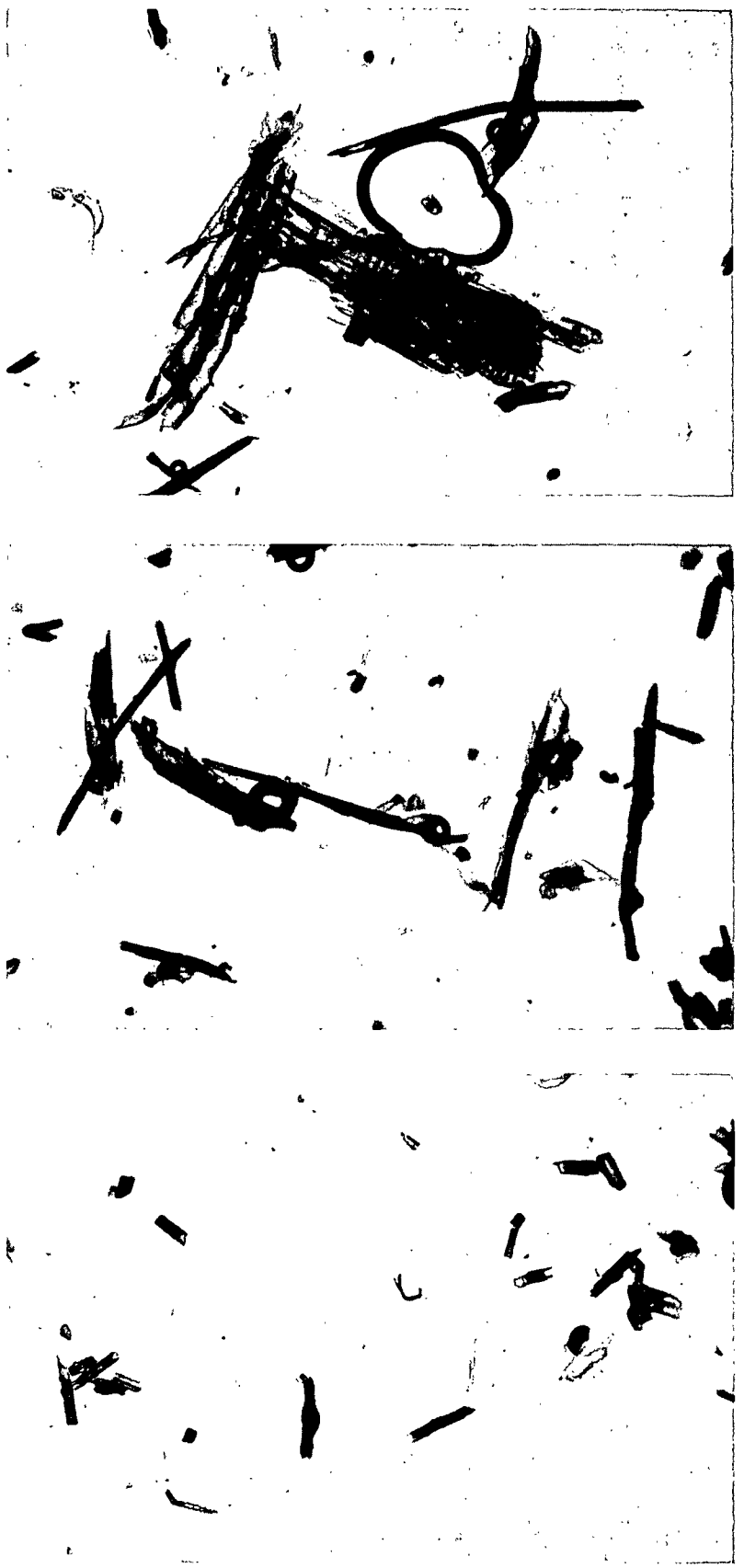

Figure 1. 68.8X. Run 59 Blanket Lint Components (Felt Side Northern Conventional Newsprint HC). a. Ray Cells and Ray Cell Aggregates Which Make up Much of the Lint. b. Typical Partial Fibers. c. Two Partial Shives. One Shows Ray Crossing. The Density and Lack of Pitting of the Other Suggest that it may be from Summerwood

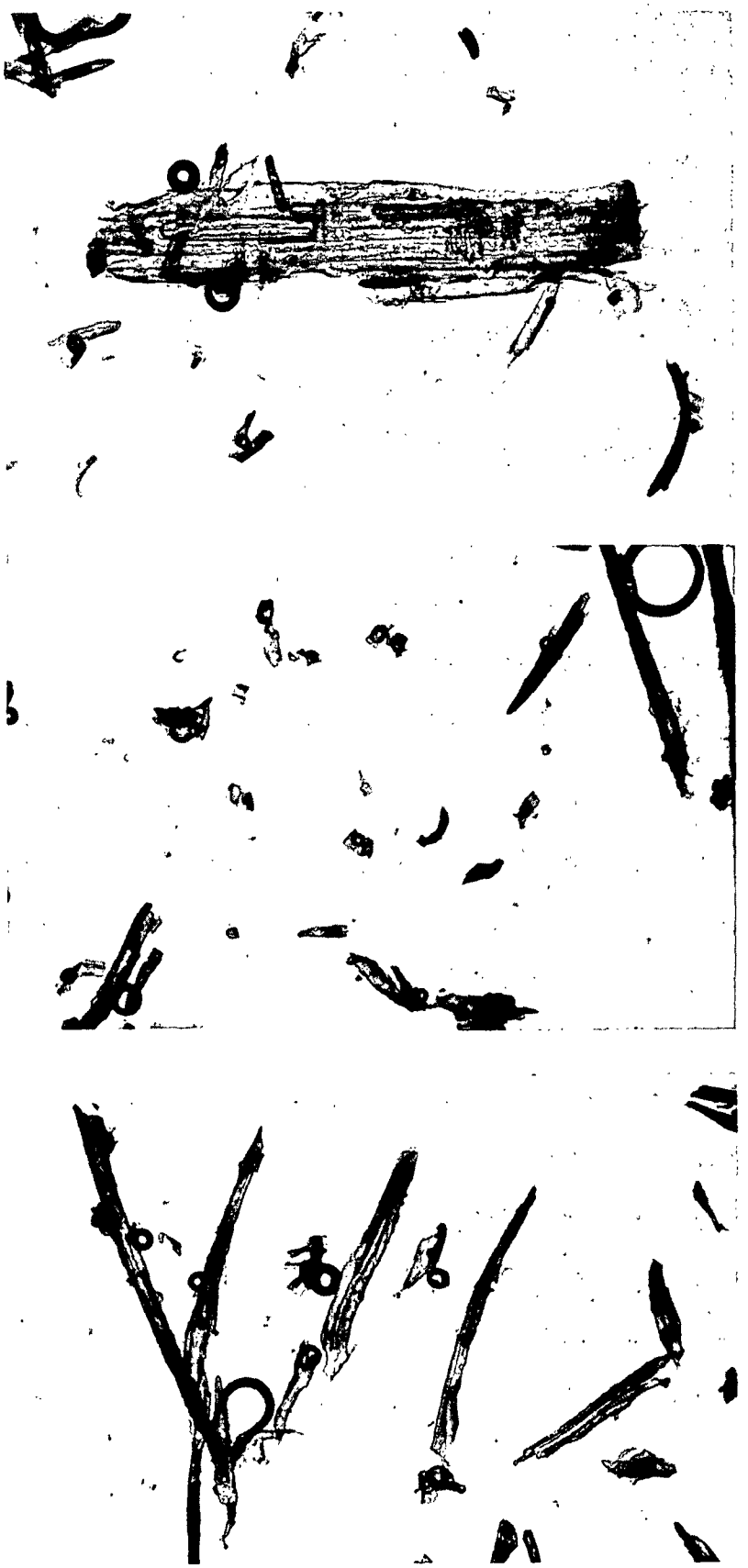

Figure 2. 68.8X. Run 28 Blanket Lint Components (Felt Side Southern Newsprint BR).
a. Typical Partial Fibers of High Density and Rigidity. b. Fiber Fragments Rather than Ray Cells Which Comprise Much of Fine Paper Debris from Southern Newsprints. c. A Shive of Larger than Typical Size

3. Partial fibers, that is, segments of fiber tracheids ranging from 0.35 to 0.8 mm. on the average (Fig. 1b and 2a). These appear rigid, dense, and usually are not extensively pitted. These characteristics suggest that they may be predominantly summerwood.

4. Short, dense shives with maximum length of about 0.8 mm. (Fig. 1c, 2c).

It is also possible to distinguish types of materials which are present in considerable amounts in the whole furnish which do not appear in the lint. These include fibrils (Fig. 3a and 4a) and fibrillated fibers (Fig. 4b). In addition, fiber segments and shives longer than 1 mm. are observed to only a very limited degree in lint.

Small amounts of lintlike material are easily found in the whole stock. Such material includes the ray cell aggregate of Fig. 3a, the partial shive of Fig. 3b, and the partial fibers of Fig. 4c. These are all particles which might be expected to lint if they occur at the surface of the newsprint.

It is clear that the press blanket is highly selective in the material it removes from the stock and accumulates during a press run. There is also evidence that the press is selective in the type of material which is transferred from the blanket by means of the plate to the ink train. In general, ink train lint tends to be coarser than blanket lint and in some cases is very obviously coarser. Ink train lint also appears to be less rigid than blanket lint. A few fibrils are present in ink train lint and this may indicate that flexible fibers are more easily removed from the blanket. No conclusion can be reached concerning selectivity of the press with respect to the paper debris which remains on the plate because plate debris was not systematically collected after the runs. However, it is known that the most serious print defects were due to specks of paper debris in the solids and dark tones on the printing plate. These specks were large enough

Figure 3. 68.8X. Newsprint Components (Northern Conventional Newsprint HC). a. Ray Cell Aggregate such as is Found in Lint from Northern Newsprint with Fibrils Which are not Found in Significant Amounts in Lint. b. A Short Dense Shive Such as is Found in Lint

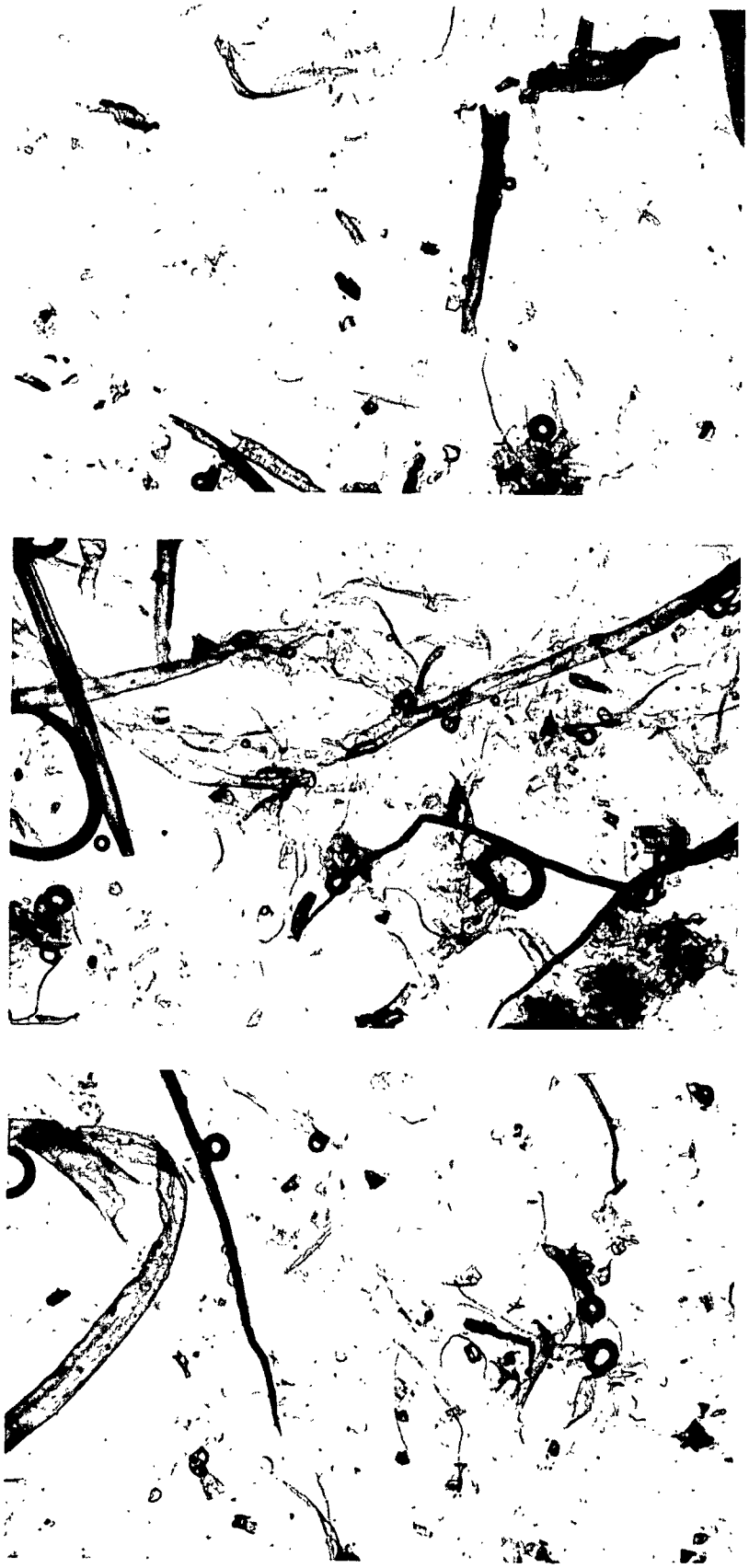

Figure 4. 68.8X. Newsprint Components (Southern Regular Newsprint BR). a. Free Fibrils not Occurring in Lint. b. Fibrillated Fibers not Occurring in Lint. c. Partial Fibers and Fiber Fragments such as are Found in Lint

to cause the inking rolls to bear off and produce a print with a dark spot surrounded by a white halo. It may be reasoned, therefore, that they were shives of considerable size.

In Report Two it was shown that there was little correlation between the quantity of the lint and the quality of the print. Table II compares the coarseness of the lint with the print quality. Correlation of rank of coarseness of blanket lint with rank of print quality is significant at the 5% level for both the felt and wire sides (taken individually). However, the correlation of rank of total amount of lint with print quality is not significant. This supports the conclusion stated in Report Two that the nature of the lint is apparently of greater importance than its quantity.

TABLE II

CORRELATION OF BLANKET LINT COARSENESS AND TOTAL AMOUNT OF LINT WITH PRINT QUALITY

Paper		Blanket Lint Coarseness, rank	Total Lint Weight, rank	Print Quality[b] Score	Print Quality[b] Rank
AO	Felt	1 (coarsest)	2	4	1
HC	"	2	1 (most)	27	5
DO	"	3	3	20	2
BR	"	4	4	25	3
CO	"	5	6	26	4
FR	"	6	5	44	6
IT	"	7	7	68	7 (best)
	r_s[a]	0.786	0.572		
AO	Wire	1 (coarsest)	6	21	3
DO	"	2	4	11	1
BR	"	3	3	16	2
CO	"	4	2	34	4
FR	"	5	5	45	6
IT	"	6	1 (most)	42	5
HC	"	7	7	73	7 (best)
	r_s[a]	0.857	0.285		

[a] Spearman rank correlation coefficient with print quality rank.
[b] Based on the average of the 90% tone and solid tone average quality ranking of Report Two.

PROPOSED FUTURE WORK

Future work should continue to emphasize the relationship between linting and quality degradation. Because of the large effect of plate lint on quality, future tests should isolate and characterize the paper debris deposited on the plate. Preferably this should be done by means which will relate the actual local accumulations on the plate to definite quality defects in the print. Even though the present work has indicated that the nature of the lint is of greater importance than the amount, quantitative lint determinations should be continued. Such determinations provide a supply of lint for further studies in addition to quantitative data.

The finding that certain heavy lint deposits were not particularly detrimental to printing quality does not mean that they would not be detrimental during a longer run when they could deposit to a greater depth and might form uneven ridges. Therefore, some runs of considerably greater length are needed.

Further work should include isolation and/or determination of the fibers of lintlike character in the newsprint with particular attention to the distribution with depth within the sheet.

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1. Browning, B. H., and Parker, J. R. Characterization of offset lint and the testing of offset papers. Proc. EUCEPA Symp. Mech. Pulp (Oslo), 67-81 (June, 1970; publ. 1971).

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APPENDIX

PHOTOGRAPHS OF NEWSPRINT FIBERS AND LINTS

Figures 5 through 11 show (a) the whole fiber of the newsprint, (b) and (c) the blanket lint from each side, and (d) and (e) the ink train lint from each side for the seven newsprints which have been studied.

Figure 5. Paper AO. 27.5X. a. Fiber from Whole Newsprint. b. Blanket Lint from Felt Side

Figure 5 (Continued). c. Blanket Lint from Wire Side. d. Ink Train Lint from Felt Side. e. Ink Train Lint from Wire Side

Figure 6. Paper HC. 27.5X. a. Fiber from Whole Newsprint. b. Blanket Lint from Felt Side

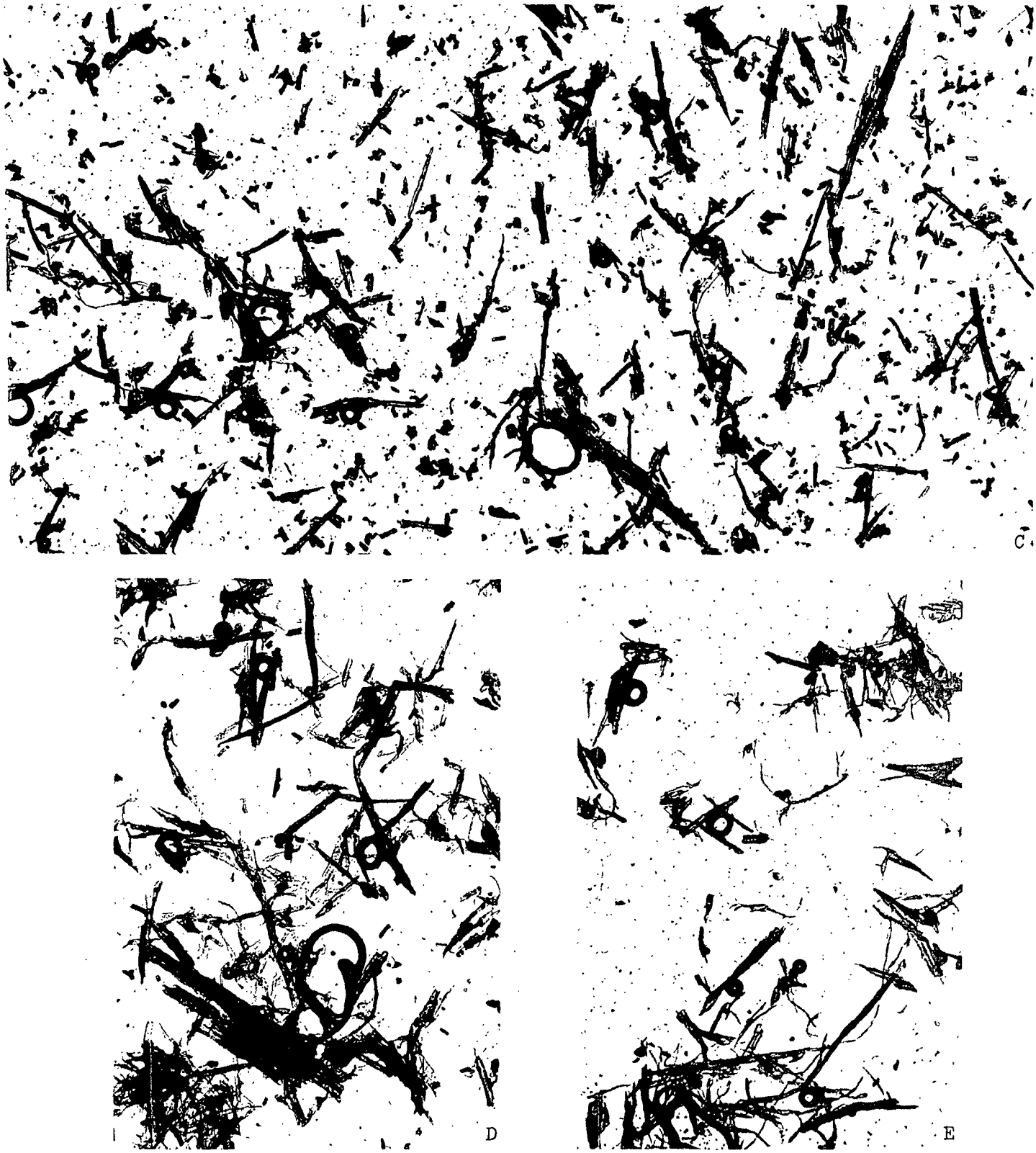

Figure 6 (Continued). c. Blanket Lint from Wire Side. d. Ink Train Lint from Felt Side. e. Ink Train Lint from Wire Side

Figure 7. Paper DO. 27.5X. a. Fiber from Whole Newsprint. b. Blanket Lint from Felt Side

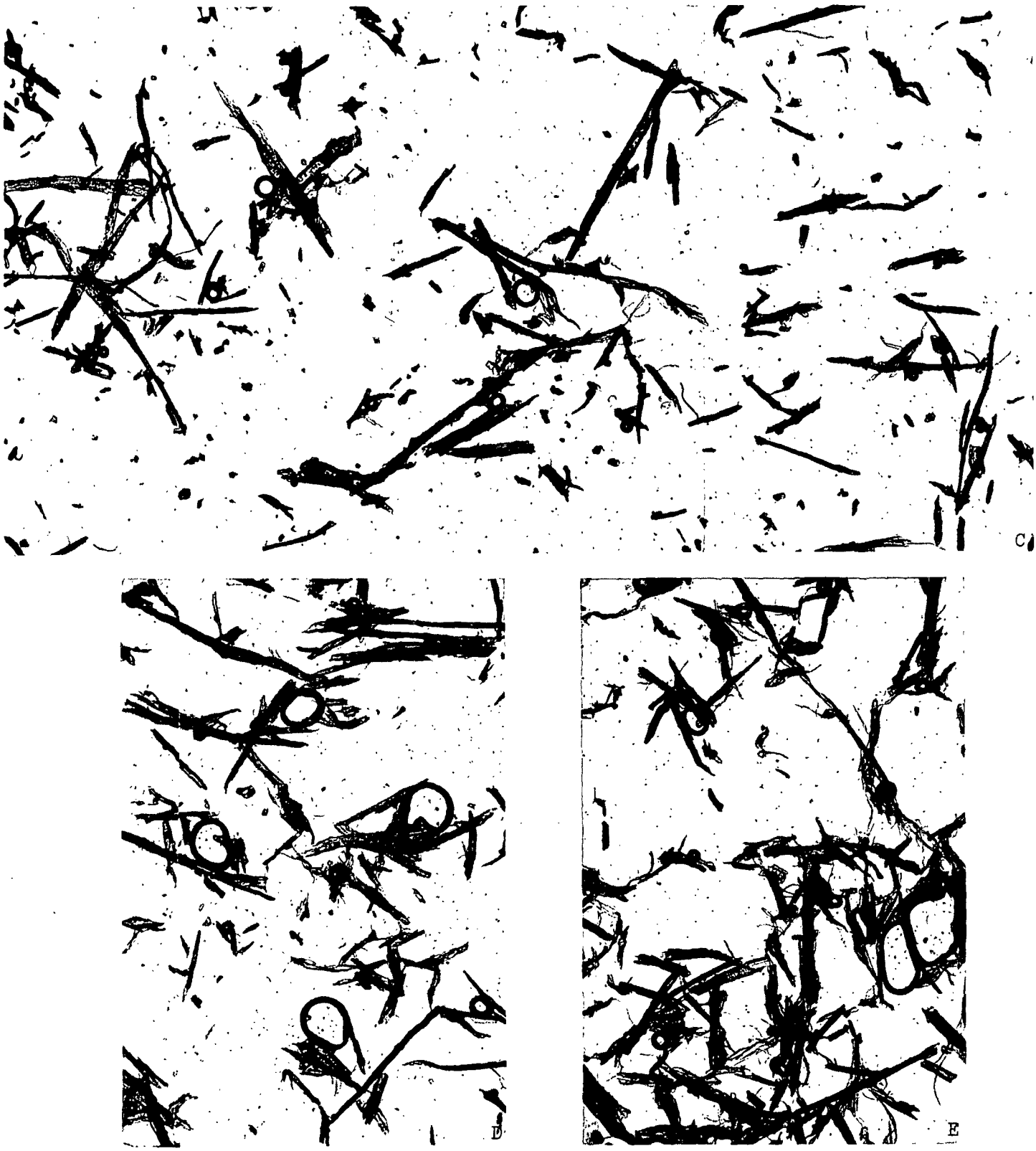

Figure 7 (Continued). c. Blanket Lint from Wire Side. d. Ink Train Lint from Felt Side. e. Ink Train Lint from Wire Side

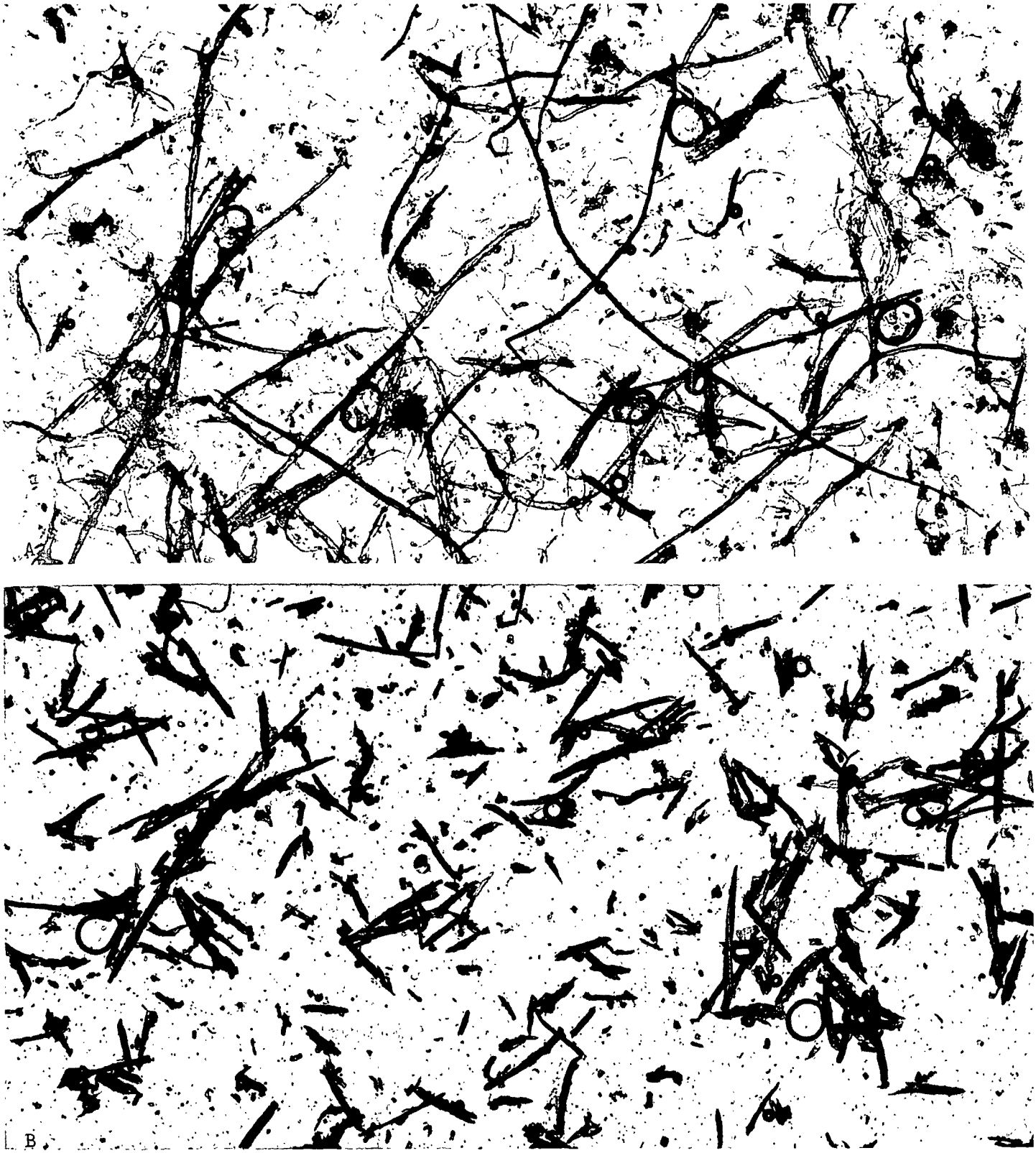

Figure 8. Paper BR. 27.5X. a. Fiber from Whole Newsprint. b. Blanket Lint from Felt Side

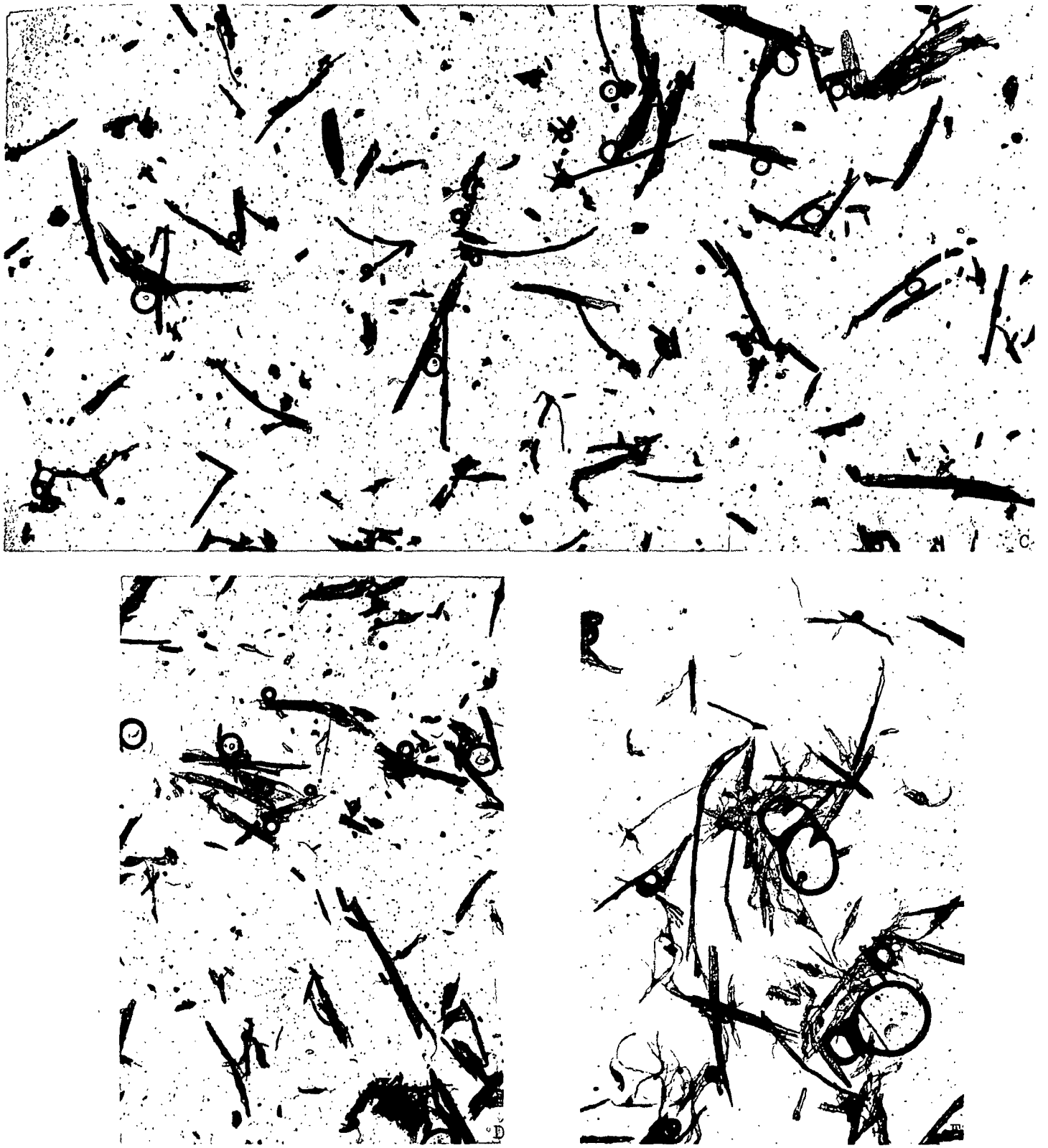

Figure 8 (Continued). c. Blanket Lint from Wire Side. d. Ink Train Lint from Felt Side. e. Ink Train Lint from Wire Side

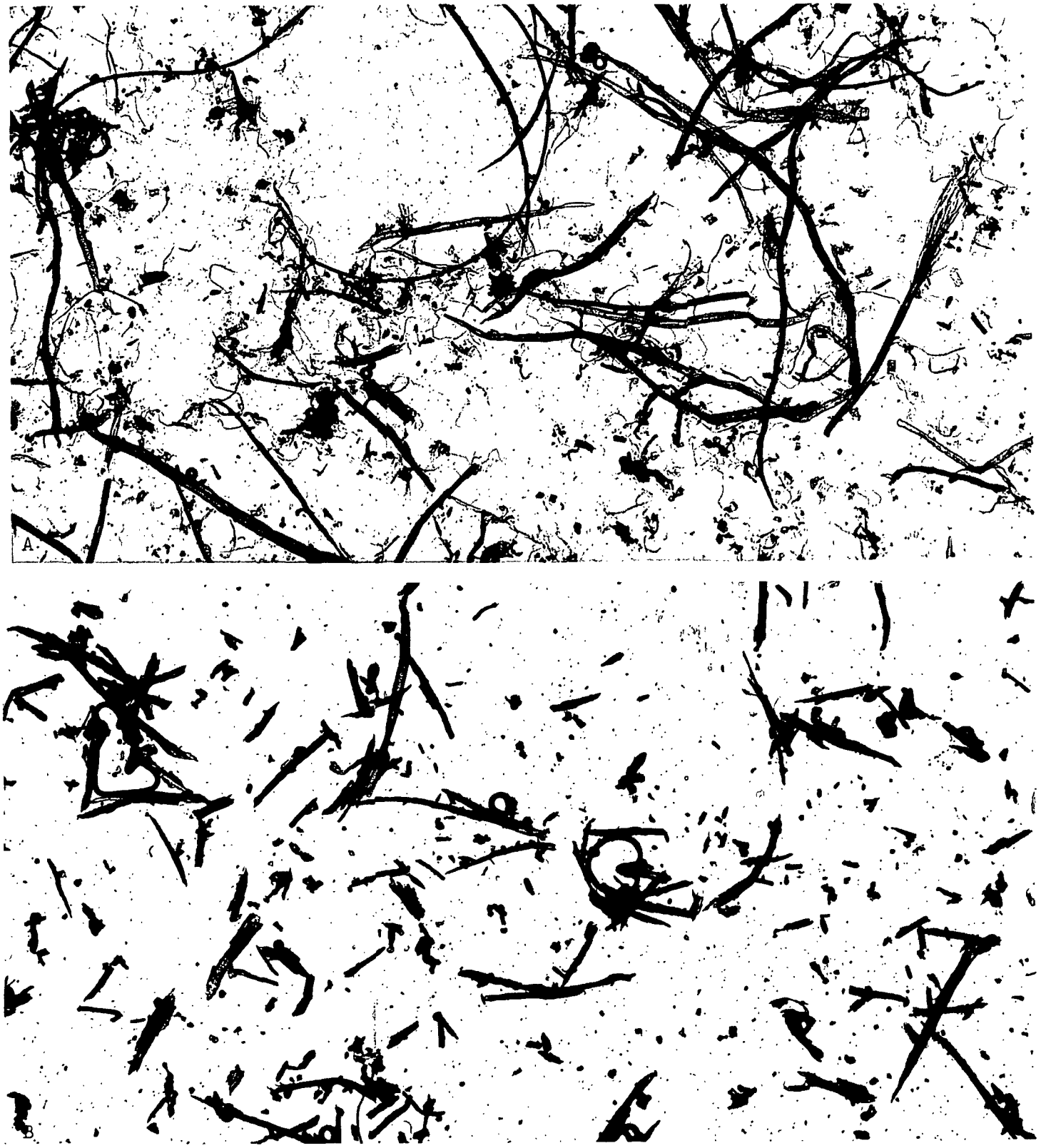

Figure 9. Paper CO. 27.5X. a. Fiber from Whole Newsprint. b. Blanket Lint from Felt Side

Figure 9 (Continued). c. Blanket Lint from Wire Side. d. Ink Train Lint from Blanket Side. e. Ink Train Lint from Wire Side

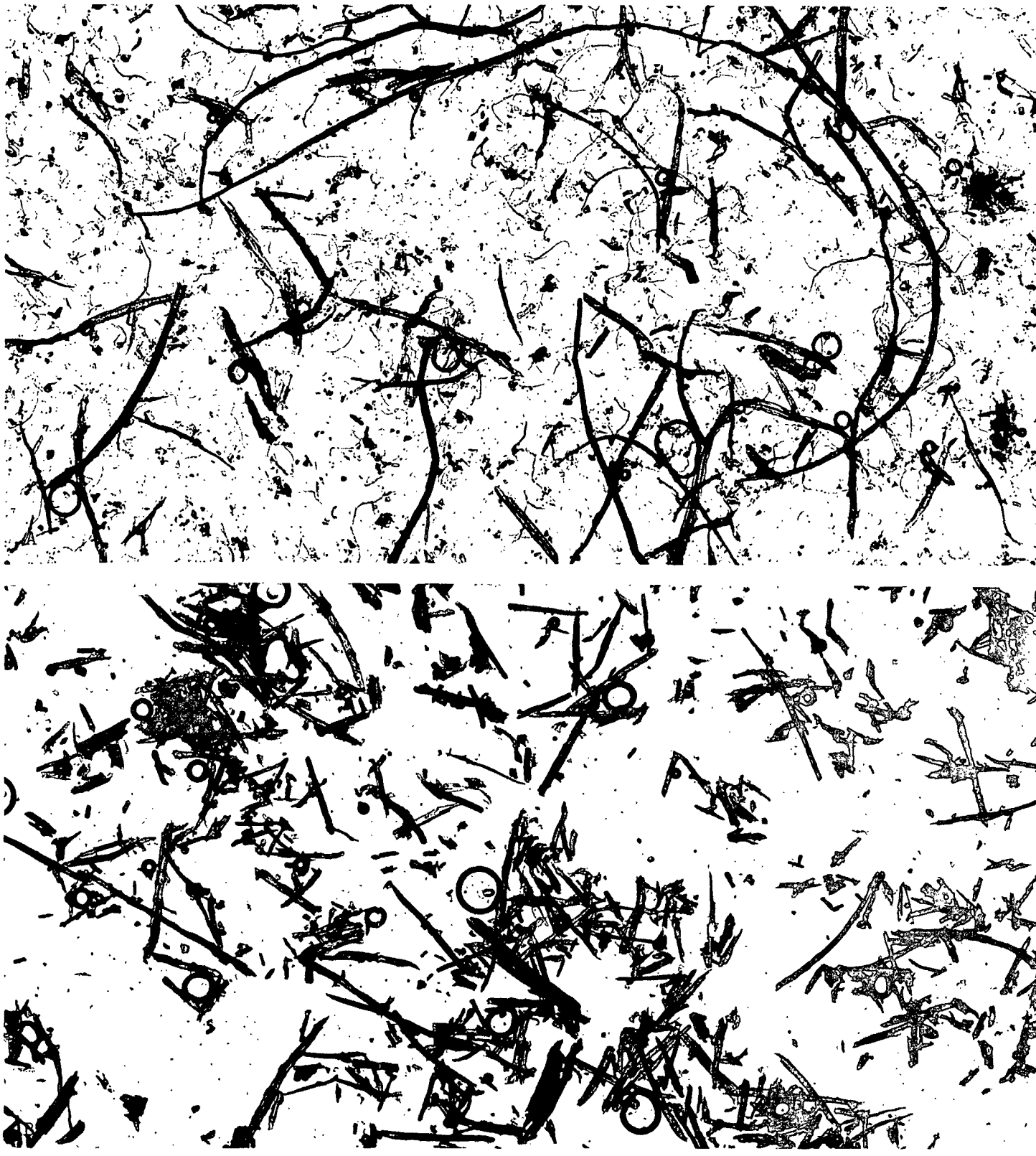

Figure 10. Paper FR. 27.5X. a. Fiber from Whole Newsprint. b. Blanket Lint from Felt Side

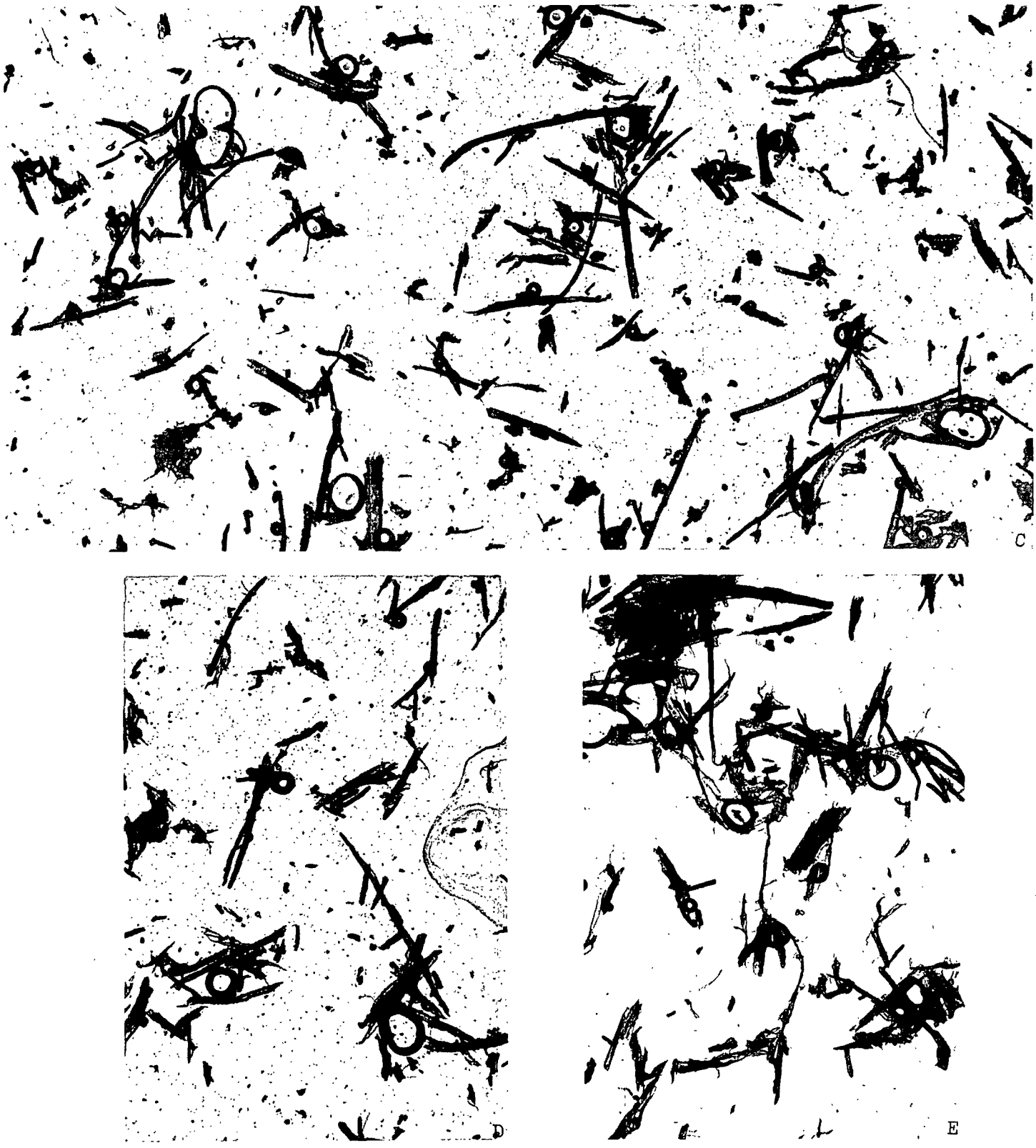

Figure 10 (Continued). c. Blanket Lint from Wire Side. d. Ink Train Lint from Felt Side. e. Ink Train Lint from Wire Side

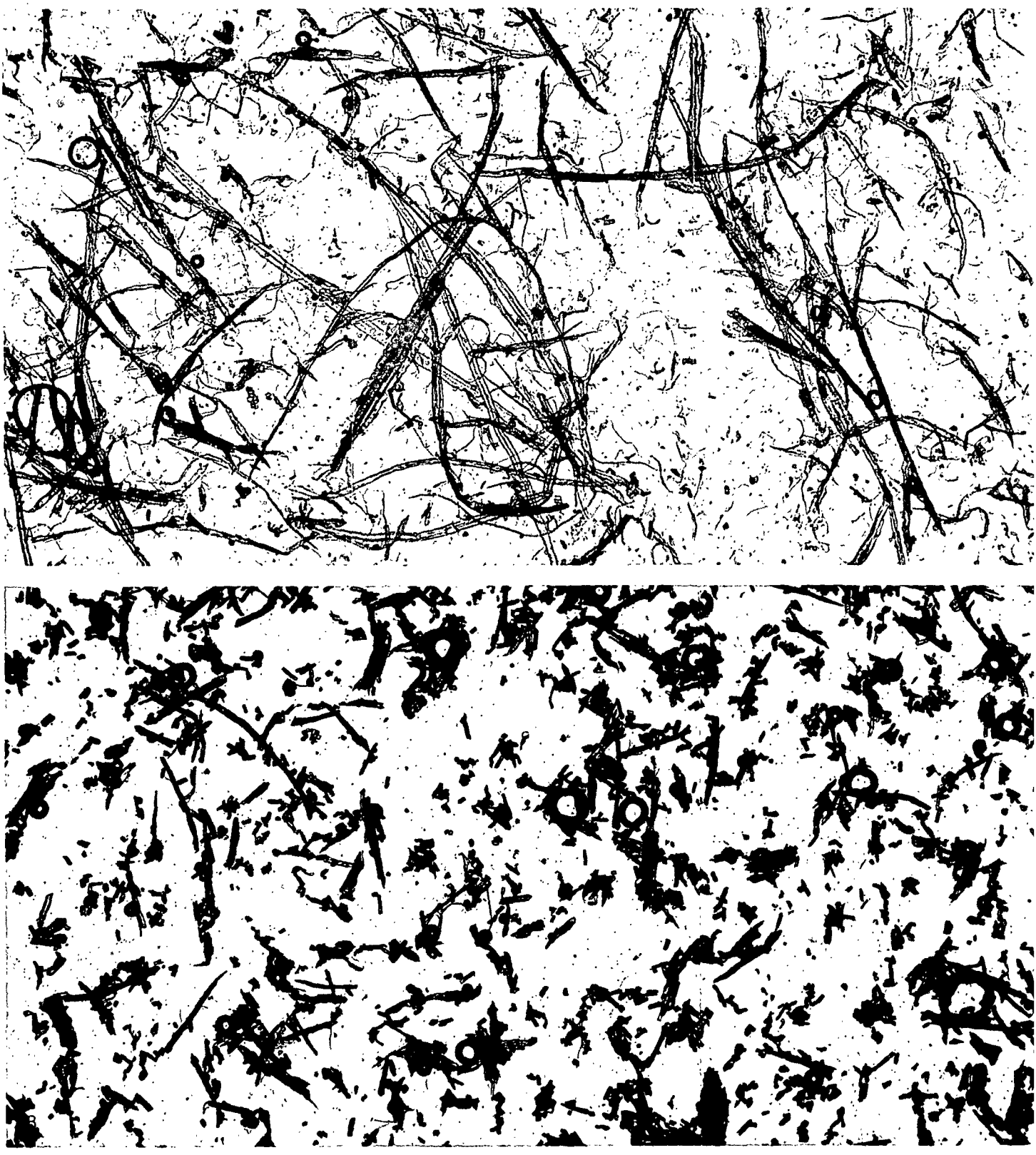

Figure 11. Paper IT. 27.5X. a. Fiber from Whole Newsprint. b. Blanket Lint from Top Side